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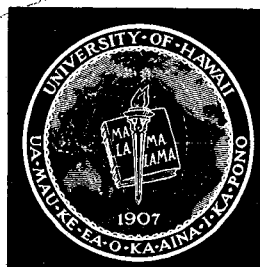
A Mathematical Theory of Conflict Dynamics

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The Dimensionality of Nations Project
Department of Political Science
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A Mathematical Theory of Conflict Dynamics

ABSTRACT

The theory proposed here is designed to produce systematic information about contemporary patterns of conflict behavior and to judge the practicality of identifying the form of these patterns over time. It is based upon the belief that behavior begets behavior--that the behavior of one nation towards another is a function of its previous experience with that nation. In other words, a nation's future behavior will be a function of both its own momentum in dealing with this opponent, as well as its expectations of the strategy an opponent is most likely to adopt when responding to an influence attempt. It is hoped that by adopting a theory of dynamic processes and placing some restriction upon the use of common sense and intuition, considerable insight into international conflict processes will be gained.

1. INTRODUCTION

The theory proposed here is designed to produce systematic information about contemporary patterns of conflict behavior and to judge the practicality of identifying the form of these patterns over time. It is based upon the belief that behavior begets behavior -- that the behavior of one nation towards another is a function of its previous experience with that nation. In other words, a nation's future behavior will be a function of both its own momentum in dealing with this opponent, as well as its expectations of the strategy an opponent is most likely to adopt when responding to an influence attempt. It is hoped that by adopting a theory of dynamic processes and placing some restriction upon the use of common sense and intuition, considerable insight into international conflict processes will be gained.

This theory will seem to contradict the many social, economic and ideological explanations for war. Yet conflict is not war; between the two lies the process of diplomacy, where the interaction of states is considered primary. Conflict is taken as a given, regardless of its roots, and the processes of states which lead to peaceful resolution of conflict or violent disruption of the status quo is studied.

The threat of war is claimed to be present in every conflict of goals between nations.

The observation that the threat of war is central in regulating the relationships between hostile powers is certainly not new. Ever since there have been human groups capable of making war, their leaders have concerned themselves with threats. The great preoccupation of statesmen throughout history has been threats of war: making them, maintaining them, and interpreting them. Nevertheless, the citizen often fails to realize their critical role. Speeches, documents, conferences, treaties: the real meaning of these matters is often lost upon him because he does not see the threat of war behind them. A diplomatic note quietly sent to a foreign power voicing 'concern' may contain a grave threat of war,

but the citizen would never know it. We can observe the actual use of force in international relations but we are curiously insensitive to the threat of force. We know that war is possible and the thought of war frightens us. But we do not realize that nations manipulate this fear day after day as an instrument of policy. (Payne 1970, xii)

Payne's argument may seem too strong. Harlan Cleveland's has stated the same general principle in less threatening terms.

Because we do not want to have to use our ultimate power, we must constantly be using more limited forms of power, (Cleveland 1966, 14-15).

Much of the current ideology in the foreign offices of national capitols seems to emphasize the uniqueness of each use of power. Those who accept this philosophy would have us believe that there are no general problems and therefore no need to approach the diplomatic aspects of conflict theoretically. If there are no recurring problems in conflict then there is no basis for generalizing about policy planning.¹ It is not true, however, that policy planners have no underlying beliefs about the nature of conflict and the appropriate responses to a specific opponent's demands.² In short, every foreign service officer knows how to respond to events as they occur, based upon his underlying beliefs about the dynamics of conflict which apply at this point in time to this particular "enemy."

I propose here to help develop a science of the dynamics of conflict so that the explanatory ideas which form the basis of beliefs

¹For a review of the problems one encounters when one suggests analytical investigations be carried out by the State Department, see Scott (1969).

²By the same token, "contingency planning" must normally deal with many contingencies that do not come to pass. In the fall of 1962, countless man-hours went into contingency planning for crises elsewhere that were thought to be possible Soviet reaction to a quarantine of Cuba. Yet, contingency planning is never wasted, for it develops the analytical skills of the planners and thus puts the government in a more "ready" position. (Cleveland 1966, p. 34)

about diplomatic behavior can be systematized. Science is a way of checking the objective bases of our beliefs (which in the scientific context are called "theories"). For the most part, the beliefs about the dynamics of conflict have been held because they fit the holder's cognitive set, not necessarily because they are related to reality. It is possible that belief systems, once established, develop according to their own dynamics and dominate instrumental concerns of policy planning. The applications of a deductive theory with appropriate test-ability ought to lead to a better, more reliable understanding of the dynamics of conflict and help prevent this unchecked application of beliefs.

Once the dynamics of conflict are well understood by policy planners and foreign policy analysts, policies which ensure that violence is reduced to a minimum can be adopted. These policy initiatives and strategic responses to opponents' demands should enable decision-makers to gain policy objectives but still minimize the potential of conflict escalating into violence. A better understanding of the dynamics of conflict would help to alleviate a number of potential problems facing Policy Planners in the decade ahead. A review of some of these problems follows.

1. The revolutionary character of the current era makes it extremely difficult to anticipate the impact of United States initiatives aimed at containing violence and limiting the scope of sub-limited wars.

Henry Kissinger has pointed out the problems of the current era.

The period after World War II marks the first era of truly global foreign policy. Each major state is capable of producing consequences in every part of the globe by a direct application of its power or because ideas can be transmitted almost instantaneously or because ideological rivalry gives vast symbolic significance even to issues which

are minor in geopolitical terms. The mere act of adjusting perspectives to so huge a scale would produce major dislocations. This problem is compounded by the emergence of so many new states. Since 1945, the number of participants in the international system has nearly doubled. In previous periods the addition of even one or two new states tended to lead to decades of instability until a new equilibrium was established and accepted. The emergence of scores of new states has magnified this difficulty many times over (1969, p. 263).

This growth in uncertainty calls for new methods for understanding and forecasting the likely responses to U.S. actions by states not socialized into what the U.S. would consider to be the normal patterns of response. The growth of sublimited war calls for techniques of arms limitation which do not adversely affect either U.S. aims in the arena of conflict or the stability of relations with other powers.

2. Just as the number of nations has increased, technology has grown rapidly and multiplied the resources available for the conduct of foreign policy.

The scientific revolution which for all practical purposes removed technical limits from the exercise of power in foreign policy, has had a destabilizing effect upon U.S. relations with developing nations around the world. The pre World War II aim of power was to assure the impermeability of the territory; until recently a state's strength was measured by its ability to protect its population from attack. The nuclear age has destroyed this traditional measure of power. The paradox of contemporary military capability is --- especially with the growth in second strike capabilities --- that a gargantuan increase in power has eroded the relationship of military capability to policy. Major nuclear powers are capable of devastating each other, they are finding it increasingly difficult to translate this capability into policy, except of course the prevention of direct challenges to their own survival. The capacity to

destroy is difficult to translate into a plausible threat even against countries with no capacity for retaliation. Thus while the margin of superiority of the United States over many other states is widening, these other nations have an unprecedented scope for autonomous action. The U.S. experience in the Pueblo affair highlights this very problem. The problem is illustrated dramatically again by the war in Vietnam. Whatever the outcome of that conflict, it is clear that the American willingness to become involved in this form of warfare elsewhere has been greatly diminished, thereby undermining the utility of this experience as precedence for dealing with conflict of this nature.

The difficulty of forming new strategies of influence is in defining how to employ power diplomatically. In the past, demonstrations of the readiness to employ military power was a sufficient deterrent to less militarily advanced nations. The current era has called for a total re-evaluation of what constitutes a politically meaningful threat. A seeming inability to answer these problems has spurred new interest in arms control negotiations especially those dealing with strategic missiles. But the assurance of containing violent conflict will not be guaranteed by arms limitation at this level. It will require the development of strategies which provide for maximum U.S. influence in regional affairs considered important to the goals of U.S. policy and which are not based upon outdated measures of power capability.

The need here is for techniques of forecasting likely responses on the part of less militarily developed nations to U.S. initiatives. Once policy analysts have a clear capability to anticipate third world actor's conflict dynamics, the requirements of military planners can

be supported with more certainty as to the effect of American influence in limited confrontations with lesser powers.

3. The role of potential partners in maintaining the peace and security of nations is in need of reevaluation.

Concurrent with developments mentioned above, the decline of preeminence of nuclear power as a tool of diplomacy, has seriously affected U.S. relations with alliance partners. A decline in the military role of NATO has been recognized by all its members. Economic growth on the part of European nations since the founding of NATO, the growth of Soviet nuclear power, and the changed nature of power in the modern period have affected the creditability of traditional U.S. dominance in alliance relationships. In the future the United States cannot aim at unity as an end in itself. It must emerge from common perceptions of necessity. "Burden sharing" will not supply the impetus to common action. In the fifties, Europeans were asking for American assistance in Asia and the Middle East with the argument that they were defending the greater interests of freedom. Today the roles are precisely reversed. Indeed, in U.S. commitments in Asia, allies in SEATO and CENTO have given the impression that it would be worse for the U.S. than for them if they fell to Communism.

The whole process of U.S. involvement in conflicts around the world needs to be reevaluated in terms of more realistic estimates of conflict processes. Questions of when it is advisable for U.S. and allied joint actions, when it is advisable for solely U.S. initiatives and when it would be more successful for others to seek to limit conflict must be based upon forecasts of likely responses to a specific nation's --or groups of nations acting jointly -- influence attempts. Only after

a deeper understanding of the current changes in the dynamics of conflict processes is gained can the role of alliance partnerships be realistically reappraised from the standpoint of U.S. policy goals. With the change in current alliance partners' views of their needs and concerns, a better understanding of their likely responses in potential matters of disagreement with the U.S. could prevent a good deal of misunderstanding in the future.

In this same vein an ability to classify relationships between opponents into those states which seem to meet demands with responses equal to the demand, those nations which tend to escalate the level of conflict over the initial demand, and those which meet an initial demand with a subdued response pattern may well be beneficial. Such a division should help in choosing specific combinations of allies which will have a settling effect in some issues and eliminating those combinations which could prove utterly disastrous to U.S. goals. The classification of actors by the patterns of conflict dynamics may take on other forms than those suggested above. The classification or taxonomy adopted should rely on criteria which lead to policy decisions that limit the level of conflict in each class of national relationships.

4. The belief that negotiations begin at the conference table has given way to the realization that tacit and verbal exchanges between adversaries prior to formal negotiations may well spell success or failure in future conferences.

In the period prior to the Paris Peace talks, 1965-1968, the public positions of parties involved in Vietnam were well stated. Hanoi offered Four Points; the NLF, Five Points; Saigon, Seven Points; and the United States, Fourteen Points. While a fair assessment of the public

actions of involved states probably will not be available for several years, the pattern of public statements can be compared with public actions in the immediate arena. The question of similarities and differences between this process and the actions surrounding the cessation of hostilities in Korea might provide insights into operational codes for conflict limitation in Southeast Asia.

One of the great mistakes of U.S. policy in Asia was the misreading of Chinese preparedness in support of the North Koreans.³ Therefore, in the Vietnam conflict, a great deal of time and effort was spent in uncovering ways to assure the Chinese that their territory would be respected in the early bombing raids along the Chinese-Vietnamese border.⁴ A more comprehensive review of Chinese responses to U.S. actions in Southeast Asia may well provide valuable insight for dealing with the Chinese in future arms limitation and conflict cessation talks.

Another area of analysis on negotiations which may prove beneficial is the comparison of moves made in conferences with moves made in the field. Admiral Joy (1955) pointed out that the Chinese displayed few moves which were accidental in the Panmunjon talks. Even the most obtuse communication was carefully chosen to serve a specific purpose. Henry Kissinger has commented on the North Vietnamese negotiating style.

All this produces the particular negotiating style of Hanoi; the careful planning, the subtle, indirect methods, the preference for opaque communications which keep open as many options as possible toward

³ See Allan Whiting, China Crosses the Yalu, 1960.

⁴ See Allan Whiting, "How We Almost Went to War With China," Look Magazine, 1969.

both foe and friend (the latter may be equally important from Hanoi's point of view). Hanoi's diplomacy operates in phases of reconnaissance and withdrawal to give an opportunity to assess the opponent's reaction. This is then followed by another diplomatic sortie to consolidate the achievements of the previous phase or to try another route. In this sense, many contacts with Hanoi which seemed "abortive" to us probably served the function of defining the terrain from Hanoi's point of view. The methods of Hanoi's diplomacy are not very different from Viet Cong military strategy and sometimes appear just as impenetrable to us. (1969, p. 115).

Hanoi's negotiating strategy is not a style which is expected to reveal itself to current American strategies of analysis: the pragmatic legal dissection of individual cases. Policy analysts cannot deal with each point on its merit, but must look at the overall pattern of demands and responses if they are to clearly judge the desires of Asian negotiators.

5. Any demonstrations of success in arms control talks must be measured against operational criteria of stability between the super powers which is, as yet, undefined.

The operational code of the Soviet Union in dealing with policy decision making has been studied by Nathan Leites (1951). His attempt was to determine the normal pattern of influence in Politburo decision making. The normal pattern of response and initiatives -- or operational code -- of the Chinese, Soviet Union and United States in direct exchanges between each other has not been specified to date.⁵ There is a good deal of uncertainty when analysts attempt to forecast Chinese responses to impending U.S. and Soviet SALT talks, for instance.

⁵ See Bendix Project Triad (AFXDOC) for a discussion of China and Soviet interactions and the relationship of these patterns to differences in national characteristics.

The current arms expenditure of all three powers is based upon the notions of deterrence. But deterrences are tested negatively by things which do not happen. A little reflection should confirm that it is not possible to demonstrate why something did not happen. The abstract nature of modern domestic debates on the advisability of such policies makes bitter debate inevitable. The same type of debate is currently raging in America over the merits and demerits of arms reduction. Some argue that reductions in the current level of armaments or cessation of future plans for envisioned weapons systems, would create a destabilizing influence on the relations among major powers. These arguments are made in an era in which the stable pattern of exchanges between the super powers is not well delineated. Once such patterns are determined, the effect of various changes in the current armament policies can be judged accurately. Such an assessment of the role of arms agreement should have two major advantages. First, it ought to make realistic assessment of strategies aimed at the cessation of violent conflict more attainable by providing a mode for forecasting the course of events. Secondly, a definition of a stable pattern of action of the major nations should have a dampening effect upon domestic disagreement as to the success of various initiatives by providing objective indicators to measure success or failure of arms limitation.

6. The environmental planning for the future, upon which U.S. posture statements are based, needs precision and reliability which are achieved only by adopting techniques of forecasting which assure the most accurate results, possible -- techniques being investigated currently in the academic community.

Indeed with the rise in the number of actors in the inter-

national system and the increasing difficulty in distinguishing between war and peace, policy planners and decision makers are faced with mounting problems in international relations. Charles A. McClelland points out that:

The eventual problem -- the difficulty underlying all other difficulties -- in international politics is that of bringing about intended effects in the absence of centralized means of control. The situation, from the standpoint of any major decision-maker of a national government, is ruled by the difficulty of knowing in advance how decision makers of other national governments will respond to his decision. Thus, the decision-maker faces the peculiar problem of having an urgent need for information about events that have not yet occurred and about conditions in the future consequence of actions he is about to undertake. It is this kind of information that is in very high demand and very short supply. The decision-maker's only means of approaching such information is to estimate the future responses of other decision makers by analyzing what the latter have done in the past. It is the best resource for reducing uncertainty. (1966, p. 135)

The planner -- as opposed to the policymaker -- does not need explicit point predictions. Like the researcher, he is concerned with classes of events, seeks trends and tendencies, and in general is willing to settle for probabilistic statements about more likely futures. The academic community and the planning community have overlapping interests; the question is how to produce mutually beneficial results from these common concerns.

From the planning standpoint, the need is for methodologies for forecasting future trends in conflict between nations. On the other hand, from the policy implementation viewpoint the need is for information concerning likely deviations from these trends and adaptive behaviors of opponents which do not conform to previous trends. The plans require predictions based upon scientific inquiry and, as such, planners should be interested in announcements from the academic

community such as the following by R. J. Rummel:

In short, what the computer enables us to do now is to build a meteorology-like science of international relations. Much as the meteorologist has developed a knowledge of weather patterns we can define regularities in international relations. Moreover, as he has delineated the crucial weather indicators like temperature, air pressure, and humidity, we can now do the same for international relations (perhaps, and it is a little more than a guess at this point, in terms of threats, mail flows, trade, tourists, and existence and staffing of embassies and legations). And most importantly, as the meteorologist can monitor the existing weather and compare this data with his previously acquired knowledge of weather patterns and shifts to forecast the occurrence of storms or pleasant weather, we may also in international relations forecast the occurrence of conflict and cooperation. (1968, p. 192)

This type of announcement as to potential computer use and computer oriented research comes close to the planner's needs for a sound predictive background against which policy decisions are made. It is to be argued here that a theory of dynamic processes in international conflict can be specified in such a manner as to predict the relationships to be found between conflicting pairs of nations. Once such a theory is rigorously articulated, its empirical scope and implications can be established. Perhaps even more important, the theory will permit modeling of the processes of conflict so that planners, by estimating the state of future conflict processes between sets of combatants can predict the outcomes of serious conflict-reducing or violence-impeding strategies. To this end, the sections following will establish the basic concerns of a theory of conflict processes, discuss the problems in dealing with predictions in a multivariate universe, present the theory itself, and finally, indicate the direction of research envisioned for the future.

2. FOREIGN CONFLICT BEHAVIOR

The study of international conflict is not limited to any one discipline. Scholars of almost every disciplinary background have analyzed international conflict. Within this group, however, a basic distinction is discernible. Those who have approached international conflict from the psychological or sociological disciplines have assumed that conflict represents an abnormal type of behavior much like a mass mental sickness (Pear, 1950, Grace, 1952, Mead, 1964, Allport, 1964, Freud, 1964, and James, 1964). Political scientists and systems theorists more often have tended to consider conflict as representing normal interaction in the face of competing goals on the part of nations (Snyder and Paige, 1958, Organski, 1958, Wright, 1942, Boulding, 1962, McClelland, 1966, and Schelling, 1960).

This theory accepts the latter perspective by defining conflict behavior as "opposition among social entities directed against one another..." (Wright, 1954, p. 146), and as "an adjustment process in which, as opposing energy systems meet, the energy of each is directed against the other to remove, dominate, or destroy it..." (Carr, *italics omitted*, 1942, p. 301).

Since "conflictual behaviors are those designed to destroy, injure, thwart, or otherwise control another party or other parties..." (Mack and Snyder, 1957, p. 218), these actions are considered to be dyadic; that is, they originate in one nation and are directed at another. Examples of such dyads are the United States and North Vietnam, and Soviet Union and China. The first nation in each dyad is termed the actor and the second nation is termed the object nation.

The focus of this theory will be on interaction -- the inter-

play of conduct -- and, therefore, on social process more than on observed or attributed traits of the actors. In the terminology current in the international relations field, (McClelland, 1966, Rosenau, 1963, Singer, 1961, Snyder, 1954, and Sondermann, 1961), the emphasis is on the dynamics of the international conflict system more than on the analyses of foreign policies.⁶ A large number of the aspects, modes and functions of international political communications will be focused upon. Others have suggested approaches for analyzing this international conflict system. Boulding (1962), for example, has sketched a static model of competition within which he locates the concept of conflict. Parties to conflict are identified, the "positions" of parties in a behavior space are conceptualized, and conflict is defined "as a situation of competition in which the parties are aware of the incompatibility of potential future positions, and in which each party wishes to occupy a position which is incompatible with the wishes of the other" (p. 5). The result is the identification of the indifference area (or "set"), the conflict area, and the trading or bargaining area. Boulding's next step is to sketch in a dynamic model.⁷ This extension of his static model borrows

⁶ Rapoport comments: "Mathematically speaking a portion of the world can be called a system if (1) at any given time the 'state' of this portion can be described by a set of values assigned to some selected set of variables, and (2) relations of interdependence can be ascribed to the variables. If, in addition, knowledge of the values of variables at some initial time and knowledge of the relations among the variables allows us to predict (deterministically or probabilistically) the state of the system at some arbitrary future time, we have a dynamic theory of the system. If we can infer only the values of some of the variables from those of others at a specific moment of time, we have a static theory." (1967, pp. 114-115)

⁷ I accept Boulding's concept of dynamics: "A dynamic process is a succession of states, $S_1, S_2, \dots S_n$, of a system at successive points in time. Dynamic systems are present if there are patterns in the succession of states. The simplest of these patterns is the difference equation, or the differential equation, but of course many other patterns are possible." (1969, p. 98)

heavily from Richardson processes and classical mathematics. The theory proposed here suggests a dynamic extension similar to Boulding's, but employing linear algebra and factor analysis.

The theory to be sketched out here has intellectual parentage in two quite diverse camps. First, the concern with the dynamic aspects of conflict stems in a large part, from the early admonitions of Charles A. McClelland. Secondly, the way of looking at social reality is quite closely related to R. J. Rummel's field theory. Before presenting the theory it may be proper to detail this intellectual parentage.

In an early article, McClelland (1961) laid out an imaginative approach to the study of conflict:

By noting the definition of international conflict as a bargaining situation in which the participants operate according to mixed motives in the range between full conflict and full collaboration, we may take advantage of insight concerning the 'impure' character of moves and countermoves in the exchanges during crises. We may reconsider the detailed events of the histories of crises as sequences of strategic plays and treat these histories as if, virtually, they were clinical records... (p. 190)

The concept of a bargaining process leads one to expect that bargaining going on during intense crisis periods will appear in the details of the interaction. If there are 'turning points' or important decisions in crises, these, too, will take shape under observations of the sequences. There is a possibility of learning a great deal about a system from the record of its performance, even in the absence of much knowledge about its main working parts: not always must one be concerned over the motives and capabilities of the 'actors'. (p. 191-192)

McClelland proceeds to suggest that once the relationships of international politics are broken down to their most elementary form they take on the basic pattern of Figure 1.

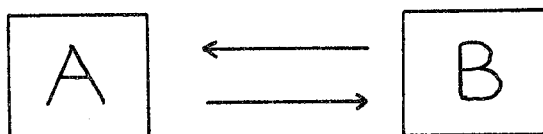


Figure 1

It follows that the facts of international relations can be selected and organized according to the two references of actors and interaction (McClelland, 1966, p. 18). For McClelland then, interaction analysis or demand-response pattern analysis has as a preoccupation the tracing of the resulting patterns and trajectories of actions. He suggests that national systems have access to only a limited inventory of demand and response actions in coping with the situations produced by system disturbances. How the government of a national system tends to select types of actions from the inventory to meet different kinds of nonroutine international situations provides evidence of its operational code in international politics (1966, p. 105).

And again he summarizes:

Without any reference to the setting of a crisis or to its larger meanings in the politics of international relations, the coding of the events of a crisis in chains of interaction sequences makes possible the identification of patterns and the comparison of forms of crisis behavior. Almost immediately, inferences are drawn and labels for several kinds of sequences are brought to mind. In the due course of an analytical study, a mapping of the complete crisis from its dramatic initial 'input' event to its tailing-off into the 'normalcy' of routine international relations becomes possible. Studies which are limited to such charting and immediate analysis will have value in putting historical data to a new use and in developing limited explanations of an aspect of international behavior. The ambition is greater, however: we wish to cope with the matter of peace and war and with the problem of control... (1961, p. 193)

McClelland suggests that we look at the pattern of actions which emanate from one nation and are aimed at another. This directed behavior will be called dyadic behavior and the unit of analysis (dyad) will be composed of an actor and an object nation. Extending McClelland's point of view, consider that the behavior of an actor nation toward an object nation is a function of the dyad's previous acts and trends as well as the previous responses of the object to earlier demands on the part of the actor nation.

Raymond Aron has raised the question as follows:

Is the 'cold war' a preparation or a substitute for total war? If the former, the two camps are simply maneuvering for position until the day of final settlement. If the latter, the propaganda battles, the struggles among national parties, the fighting localized in Greece and Korea, constitute the war itself - inevitable because of the ravages of violence. (1954, p. 226)

McClelland suggests that today's conflict may be an alternative to war.

On the ground that the 'cold war' represents some kind of change in the structure of the international system, it may be argued that the long series of crises since 1946 is a part of the process of experimenting with and learning a 'new politics' of international relations. In a word, the crises can be conceived as leading, step by step, away from general or total war. (1961, p. 188)

What is missing from the above development is a way of looking at social reality in such a way as to make explicit the kinds of explanatory statements which can be made about these processes. The current effort is based upon the work of R. J. Rummel (1965, 1969). Rummel's theory is elaborated mathematically, drawing upon the theorems of n-dimensional space and linear algebra. Field Theory asserts that international behavior is the consequence of socio-economic, cultural, geographic and political differences and similarities between nations. The theory consists of seven axioms describing social reality and relating the behavior of social units to their attributes. Since the interest here is in Rummel's description of the behavioral aspects of social reality, the following discussion is devoted only to this subportion of his axiomatization of Field Theory.

The infinite number of interactions--behavioral acts--of social units (dyads) can be defined as a vector space bounded by the total

number of social units.⁸ Within this space, each interaction variable can be defined as a vector, with elements equal to the value of dyads of this type of interaction (for example the threats of nation $i \rightarrow j$), and direction from other behavior vectors being a function of the correlation between the behavior for the dyads. All the intercorrelations between behavior constitute the social system. This system, then, is defined by the interdependencies among the actions of nations toward each other--by the total configuration of behavior vectors for dyads.

These aspects of behavior space may be exemplified for threat and accusation interactions for three dyads, the United States to China (U.S.A. \rightarrow C.P.R.), China to the United States (C.P.R. \rightarrow U.S.A.), and the Soviet Union to China (U.S.R. \rightarrow C.P.R.). These dyads are represented by the coordinates in Figure 2. The interactions of concern, threats and accusations, are plotted as points P_1 and P_2 respectively, in terms of hypothetical values of each dyad. A vector is formed by drawing a line from the origin to the points. The angle, θ , between the vectors is then a function of the product moment correlation between the components X_1, Y_1, Z_1 of P_1 and X_2, Y_2, Z_2 of P_2 . The relationship between these vectors define a system in three dyad, two behavior space.

⁸The next five paragraphs are close paraphrasing of R. J. Rummel, (1965, p. 186). Unfortunately, Rummel explains this view of social reality only in terms of attribute space and then makes the logically correct statement that the same holds true for behavior space. Thus, I had to alter his discussion slightly to put it in terms of dyadic behavior.

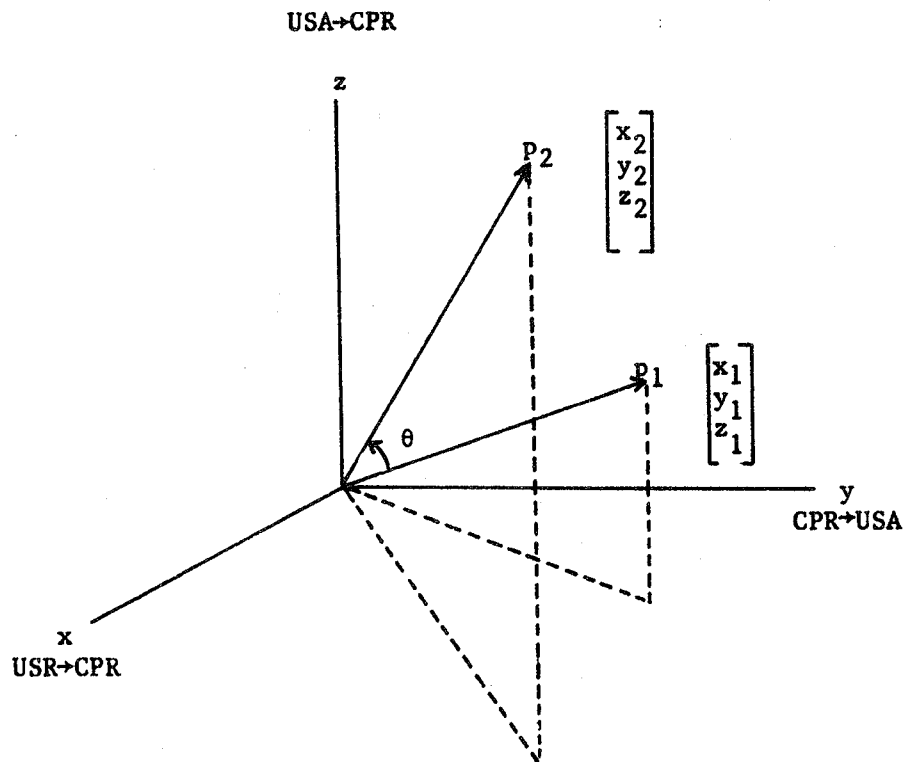


Figure 2

In the above fashion, the interaction of all dyads under analysis can be transformed into vector in Behavior Space, with a unique magnitude and position for each. This behavior space is spanned by a basis, or set of dimensions, which generates the space.⁹ In other words,

⁹ The K number of vectors of B are infinite, i.e., $k \rightarrow \infty$. Theoretically, these K vectors are linearly dependent. that is, for any particular vector b_k it is theoretically possible to find a set of g number of behavior vectors for which

all interaction vectors are linearly dependent on a set of dimensions, while the dimensions themselves are linearly independent of each other. A vector space contains a number of bases, although the dimensionality of a space is unique. For every vector space there is a basis containing dimensions which are mutually orthogonal (uncorrelated). These dimensions may be considered as a coordinate system with coordinates at right angles to each other. Within field theory, they define the state of the behavior system.

The state of the system also includes the dyads, which can be projected as vectors into behavior space. The precise location of a dyad is given in terms of the linear dependence of the dimensions of the behavior of actor to object. The structure of the theory thus entails a geometric representation of the interrelationships among the behavior of dyads.

As an example, consider the behavior space of dyads as shown by three orthogonal dimensions: negative communications (X), negative sanctions (Y), and official acts of violence (Z).¹⁰ Figure 3 shows the

9(continued)

$$b_k = \alpha_1 b_1 + \alpha_2 b_2 + \dots + \alpha_g b_g,$$

where g is finite and at least one of the α coefficients is not equal to zero.

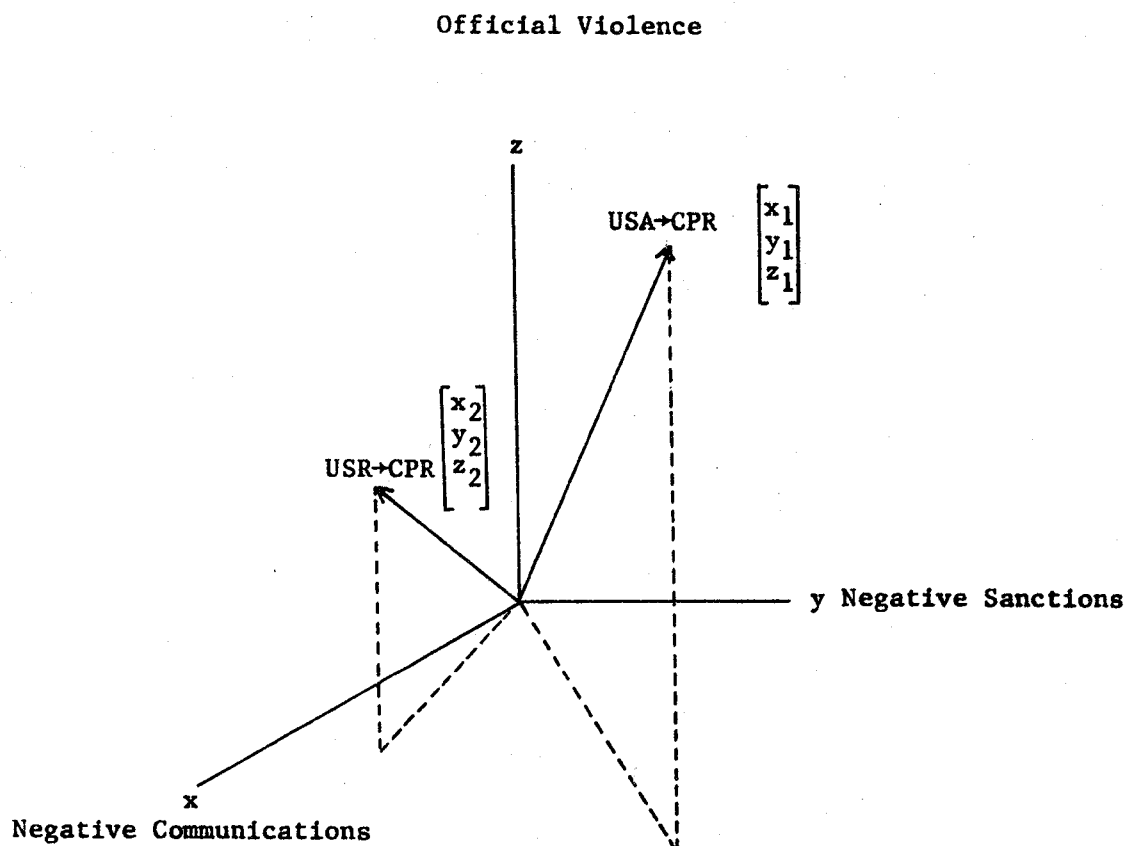
Given that each of the K vectors can be expressed as a linear combination of g other vectors, there exists one set of M linearly independent vectors to which all the others are linearly related, where $M \leq g$. In linear algebra, such a set is called the basis of the space and can be denoted

$$B = L \{S_1, S_2, \dots, S_m, \dots, S_M\}.$$

If a M member set of vectors, S_m , is the basis of a space, these vectors are called generators or dimensions of the space. This expression arises from the total dependence on them of all other vectors in the space.

¹⁰These dimensions were actually found in preliminary analysis over a 12-month period. See Phillips (1969).

Soviet Union to China (U.S.R.→C.P.R.) and United States to China (U.S.A.→C.P.R.) dyads as vectors represented in this three dimensional behavior space.



Rummel further points out that the adoption of this view of behavior by field theory has the following benefits:

- (1) It relates behavior to the total situation in which social units interact.
- (2) It is a fully mathematized theory drawing on the field of linear vector algebra.

(3) The theory incorporates general systems theory and makes it mathematically specific in application to social behavior.

(4) The mathematical structure of standard social science techniques, such as correlation, multiple regression, and factor analysis, are part of the analytic component of the theory, allowing for empirical testing within the theory's mathematical context.

(5) The theory facilitates the integration of empirical findings based on correlation, regression, and factor techniques.

(6) Social concepts, such as social distance, can be given mathematical meaning within the theory, and can be treated as theoretical concepts to be used in deduction, without the need for operationalization.

(7) The theory is based on social relations and relative positions, and avoids the unfortunate tendency of social theories to be classificatory. (1965, p. 183).

Having specified a desire to explain the dynamic unfolding of conflict for each dyad in the system and having reviewed those aspects of field theory which seem to offer an appropriate approach to describing social reality, we can now discuss a specific theory of conflict dynamics. A theory is a systematically related set of statements, including some law-like generalizations that are empirically testable...it is the function of scientific theories to explain or predict (Rudner, p. 10 and 61).¹¹ Scientific theories apply the

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The formal structure of a scientific explanation of some specific event has three parts: first, a statement E describing the specific event to be explained; second, a set of statements C_1 to C_n describing specific relevant circumstances that are antecedent to, or otherwise causally correlated with, the event described by E; third, a set of lawlike statements L_1 to L_n , universal generalizations whose import is roughly, 'Whenever events of the kind described by C_1 through C_n take place, then an event of the kind described by E takes place.'

In order for these three sets of statements actually to constitute an explanation of the event, they must fulfill at least two conditions: first, the E statement must be deducible from the C and L statements together, but not from either set alone, and

law-like statements constitutive of them to explanatory or predictive arguments of the sort required by deductive inference making.¹² If precision and reliability are to be added to forecasting international relations, the requirements of scientific theory making and deductive logic become serious issues of concern.

second, the C and L statements must be true. A skeleton outline of a scientific explanation looks like the following.

$$\begin{array}{c} L_1 \dots L_n \\ C_1 \dots C_n \\ \hline \therefore E \end{array}$$

It is of some interest to note that the logical structure of a scientific explanation is identical with that of a scientific prediction, the only difference between them being the purely pragmatic one of the temporal vantage point of the inquirer. In the case of explanation, we have, so to speak, our E (the E is vantage point), and seek the appropriate L's and C's under which to subsume it; in the case of prediction, we already have our L's and C's and seek instead an E (about an event not of the scientist's past) that they imply. It follows from these considerations that we have an explanation for an event if, and only if (from a different temporal vantage point), we could have predicted it....

There are two other comments about explanation or prediction that are germane to our discussion. First, the use of lawlike statements (whose logical form is that of universal generalizations) is an indispensable prerequisite to the accomplishment of either. Second, and associated with this, we can now say with precision what we mean when we assert that it is a function of scientific theories to explain or predict: Scientific theories provide the lawlike statements constitutive of them to explanatory or predictive arguments of the sort just outlined. (Richard S. Rudner, Philosophy of Science, pp. 60-61).

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"Mathematical models of this type derive their power from the fact that once relations among variables are specified, the resulting theory is quite independent of the content of the variables. For example, it does not matter whether we are studying the distribution of a population according to age brackets, incomes, professions, or national origins. All we need to know is the laws of the dynamic interrelations of the relevant variables. If two such sets of laws of interaction are isomorphic, so will the resulting theories. The mathematical model is thus a great 'unifier' of theories by virtue of the fact that it abstracts relations from content. Only

3. THEORY OF CONFLICT DYNAMICS

The theory is composed of five axioms. The first four postulate that reality exists in a specific manner, apriorily. The fifth, then is the law-like statement which when taken together with the first four postulates can be employed in scientific explanation.

Axiom 1. International relations is a field consisting of all the interactions of nations.

Here the term field is consistent with the concept of vector field in linear algebra. Social reality is defined as international relations and social units as nations. Interaction is defined as an action of one actor nation towards a specific object nation. This action couples the two together into a dyad. Thus an accusation sent from India to China is an action coupling them. The action involved is directed and termed dyadic behavior. The dyadic behavior of the U.S. to the U.S.S.R. is not necessarily the same as the U.S.S.R. to the U.S.

Axiom 2. The complex actions between nations can be represented by a behavior space into which interactions are projected as vectors.

This behavior space is analytically conceived of as a vector space. Thus, the theory can be imbedded in the structure of linear algebra and such mathematical concepts as dimension, basis, linearity and transformation, with associated theorems of linear algebra, can be drawn upon in further structuring the theory and deductions therefrom. More importantly, Axiom 2 is a bridge over which multivariate techniques such as factor analysis, multiple regression, and canonical analysis

relations enter into the making of a mathematical theory." (Rapoport, pp. 118-9, 1967) Thus, while the theory is stated in conflict terms here it may just as easily apply to all forms of behavior and even to other units of analysis such as groups or individuals.

can be bought to test deductions of the theory.

Axiom 3. The behavioral space is spanned by dimensions which generate the space and which are finite and empirically determined.

The dimensions generating this space are termed a basis of the space. This powerful axiom postulates the reduction of dyadic variation along a potentially infinite number of variables, each measuring some aspect of dyadic behavior, to a small number of dimensions without loss of information. As a vector space, behavior space contains not only the dyadic behavior vectors (variables) such as threats, boycotts, and exports, but also all linear combinations of these vectors. The number of such linear combinations is infinite. Algebraically, if vectors B_i and B_j are in the behavior spaces, then any vector $B_n = \alpha_i B_i + \alpha_j B_j$, where α_i and α_j are any real numbers (scalars), is also in the space.¹³

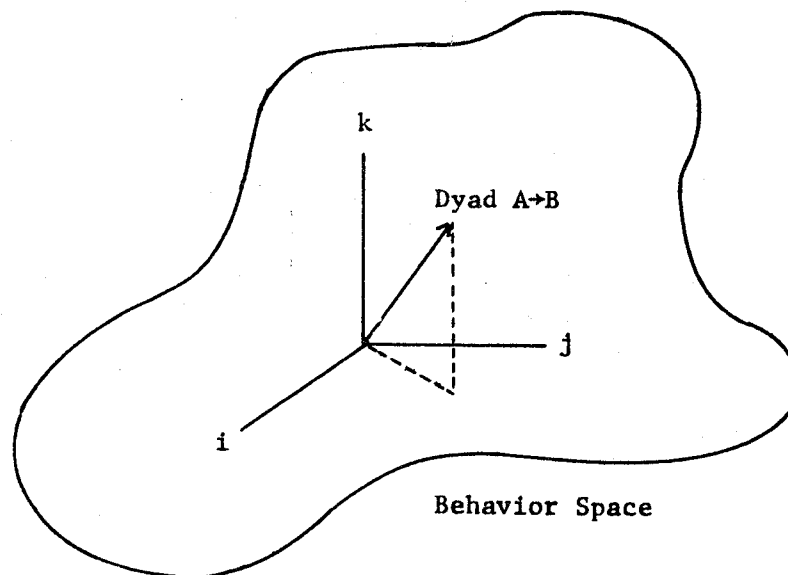


Figure 4

¹³ Let me offer this slightly biased quote in support of my view of social reality: "Among the splendid generalizations effected by modern mathematics, there is none more brilliant or more inspiring or more fruitful, and none more nearly commensurate with the limitless immensity of being itself, than that which has produced the great concept variously designated by such equivalent terms as hyperspace, multi-dimensional space, n-space, n-fold or n-dimensional space, and space of n-dimensions." (Keyser, 1916, p. 101)

$\Omega(t_\ell)_{j,A \rightarrow B}$ = the frequency of oscillation about the trend times 2 for dyad (A→B) on dimensions (j) at time (t_ℓ) .¹⁵

$\alpha_{j,A \rightarrow B}$ = the phase of the oscillation (or the position) of a dyad on the oscillation curve at time (t_0) for the j dimension of behavior space of dyad (A→B).

$T(t_\ell)_{j,A \rightarrow B}$ = the trend in the movement along dimension (j) for dyad (A→B) at time (t_ℓ) .

This emphasis on the oscillatory motion of a dyad's behavior can be depicted as in Figure 5.

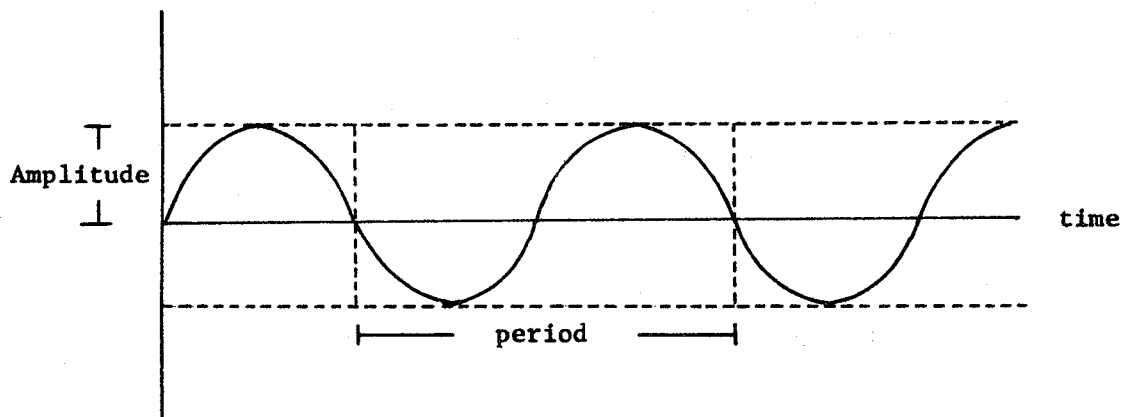


Figure 5

¹⁵ $\Omega(t_\ell)_{j,A \rightarrow B} = \frac{1}{2\pi (2(\frac{1}{2}p(t)))}$ where p = the period of the cycle of movement about the trend.

The horizontal axis represents time and the vertical axis represents any unidimensional source of variation --- in this case the dyad's projections (scores) on the dimension j across time.

The distance between the horizontal axis and the peak (point of zero slope) is the amplitude. The period is the length of time which elapses between two positive or negative peaks. It has the units of "time per complete cycle" and it increases in magnitude as the oscillatory motion slows down. The frequency is the inverse of the period. It measures the number of cycles per time unit. Frequency increases as the speed of the oscillations increases and because of this characteristic is used more often than the period to describe the speed of oscillations.

In general it does not seem reasonable to assume that either the amplitude or the frequency of the oscillations will remain constant over time. It is therefore necessary for us to include these as variable in the equation of motion which is developed. The last concept which needs explaining is the phase of a dyad's oscillation. The position of a dyad on the oscillation curve at time t_0 is its phase. This term is necessary since t_0 is chosen arbitrarily with no assurance that all dyads will be beginning their oscillations at that particular point in time.

The notion that behavior follows a cyclic path is not a new concept in international relations. A long historic perspective which was revived in the writing of Spengler and Sorokin has come to fruition in the quantitative analyses of Moyal (1949), Dewey (1969), and Denton & Phillips (1968). Even the notion that over the short run, behavior follows an oscillatory path was suggested by Smoker (1969) in his analysis of Sino-Indian conflict.

This axiom is an attempt to state explicitly a means of spelling out the form of this observed regularity in behavior.

It is necessary that equation (1) have some limits placed upon it or the theoretical projections will be accurate by definition of the procedures used. Each of the three major concepts in equation (1) -- amplitude, period, and trend -- is estimated by a polynomial regression. If the number of parameters equals or exceeds the number of observations the equations can completely reproduce the actual observations.

Ezekiel and Fox (1967, pp. 300-301) discuss a correlation coefficient which is corrected for the number of parameters. They show that the amount of variance accounted for by the theoretical projections can be corrected for the number of parameters by:

$$\bar{R}^2 = 1 - (1 - R^2) \frac{N-1}{N-M} \quad (2)$$

where \bar{R}^2 is the corrected amount of variance accounted for.

R^2 is the square of the correlation coefficient.

N is the number of observations.

M is the number of degrees of freedom used.

Thus when one correlates the theoretical projections obtained from equation (1) with the actual data of dyadic conflict behavior the accuracy of these projections relative to the number of parameters can be judged by using equation (2) to adjust the correlation. As a test of the isomorphism postulated between terms in the theory and data, we would require that at least 50 percent of the variance in behavior scores be accounted for by equation (1), after being corrected for the number of parameters.

Axiom 6. The behavior of an actor nation toward an object nation in a specific dyad is a function of the actor's previous acts and trends

The propensity of a dyad to continue using a specific type of behavior as indexed by dimension (j) is affected by events which happened in the past. These forces from the past are believed to be the actor's mix of behavior in a similar period and his opponent's responses at that time. There is a time lag built into this relationship. The behavioral pattern being predicted will have a cyclic period of a varying time length and the length of this period at any time (t_m) will determine the time lag in each case. Thus the lag will vary from time to time for a specific dyad on a specific behavior dimension, but it is specified apriorily in the theory and cannot be varied at the whim of the investigator.

A good deal of support can be found for this view of interaction sequencing of conflict behavior. Certainly the work of Charles A. McClelland emphasizes the patterning of conflict behavior and its inherent reciprocity (McClelland, 1968, 1969, 1970 and McClelland et al. 1967). John Burton is developing a communication perspective similar to this view. He views states as "political systems operating within an environment of other states to which they are adapting and responding: National interests are not fixed goals and include there adoptive processes." (1969, p. 10). Without attempting to define "national interests", I have accepted the notions of adoption and response and am suggesting, as is Burton, that they are based upon expectations of future responses gained by experience in the past of dealing with an environment which can most certainly be differentiated into objects of conflict. Holsti, North and Brody share this view:

Essentially, then, it is by projecting past experience into the future that human beings make decisions; and statesmen, in this respect, are not exceptions. Foreign policy decisions, like other human decisions, imply not only an abstraction from history, but also the making of 'predictions'--the assessment of probable outcomes. These two operations may be undertaken almost unconsciously, but they are nonetheless real and inescapable. The Marshall Plan was based upon a prediction, derived from some

Whether the process tends to adjustment in certain issues and lock in others has yet to be discovered. In any event, it may be argued that the long series of crises since 1946 is part of this process of experimenting with a "new politics" of international relations. Without reference to the setting of a relationship or the larger meanings of policies in international relations, this theory is an attempt to describe the chains of interaction sequences between nations, to predict the future patterns of interaction, and to compare the forms of conflict patterns.

At this point, the unity of the theory should become apparent. Equation (3), which is the corner-stone of the theory, seeks to explain the future behavior of one actor towards a specific object nation by employing the past propensity to act in a specific manner, from equation (1), tempered by past experience with this actor in similar settings. Past experiences take the form of forces controlling the equation of motion, equation (1), and are measured by the opponent's behavior and by the other behavior of the actor towards the opponent at the point in their past relationship when the actor had employed a similar amount of a specific action. Whether the actor applies the same amount of a specific behavior this time will be influenced by his memory of that past experience and his tendency to respond to similar situations in similar ways.

4. SOME POSSIBLE EXTENSIONS AND RECONSIDERATIONS

It is expected that there will be several dimensions of behavior.¹⁸ The movement of a dyad along each dimension will fluctuate around a trend line specific to that dimension. This view of social reality presents some interesting possibilities regarding the prediction of crises and high

¹⁸ Preliminary analysis suggests five dimensions. (Phillips, 1969)

conflict periods. Most of the time, the peaks in amplitude for each of the conflict patterns will occur at different times. If the frequencies of the fluctuations are different -- as is expected -- the peaks for each dimension should coincide, occasionally. When the peaks co-occur, there will be high relative conflict on several dimensions of behavior for that dyad. These periods ought to coincide with decision-maker's impressions of "crisis" situations. This accords with McClelland's (1965) and Phillips' (1969) findings that during crisis periods, there occurs a wide variety of increased conflict behavior, or in the theory's terms, there occurs a relatively high level of conflict behavior on several conflict patterns. To the extent that the fluctuations are regular and stable, it would be possible to anticipate the co-occurrence of these peaks.

An equally intriguing possibility is that the peak in violent conflicts for a number of dyads may occasionally co-occur. Since the frequency and amplitude of each dyad's violent conflict patterns should be expected to vary, the peaks would occasionally co-occur. When there are a number of dyads exhibiting high levels of military violence this period of co-occurrence may be a period of severe stress on the international system. If decision-makers can anticipate the likelihood of such an occurrence, they could weigh the possible effect of maintaining their current pattern of behavior.

Previous discussions of behavior space have assumed that all behavior is considered in one space. But it is also possible to classify behavior into subspaces, each dealing with a specific issue area. For instance, one subspace might deal with official negotiations while another subspace might contain all behavior between nations which does not occur

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